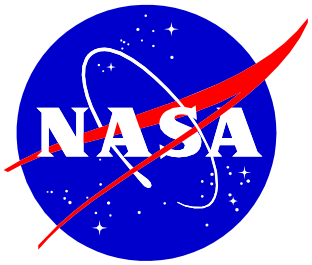
# GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT

# MISSION ASSURANCE REQUIREMENTS (MAR) FOR THE GLAST BURST MONITOR (GBM)

**April 18, 2003**




**GODDARD SPACE FLIGHT CENTER**
**GREENBELT, MARYLAND**

GAMMA-RAY LARGE AREA SPACE TELESCOPE
(GLAST)
PROJECT

# MISSION ASSURANCE REQUIREMENTS (MAR)

FOR THE
GLAST BURST MONITOR (GBM)

April 18, 2003

NASA Goddard Space Flight Center

Greenbelt, Maryland

**GLAST Project Mission Assurance Requirements (MAR) for the GLAST Burst Monitor (GBM)**

---

**Prepared by:**

*Original Signed*

Ronald E. Kolecki Date
GLAST Systems Assurance Manager

**Concurrence:**

*Original Signed*

William Browne Date
GLAST Burst Monitor Instrument Manager

*Original Signed*

Steve Elrod Date
GLAST Burst Monitor Project Manager

**Approved by:**

*Original Signed*

Kevin Grady Date
GLAST Project Manager

**CHANGE RECORD PAGE**

**DOCUMENT TITLE:** GLAST Project Mission Assurance Requirements (MAR) for the GLAST Burst Monitor (GBM)

**DOCUMENT DATE:** April 18, 2003

| ISSUE | DATE | PAGES AFFECTED | DESCRIPTION |
|---|---|---|---|
| Original | 04/18/03 | All | Baseline. CCR 433-0148. |
| CH-01 | 10/31/03 | ii and 12 | Baseline. CCR 433-0196. |

# TABLE OF CONTENTS

# CHAPTER 1. Overall Requirements

## 1.0 Overview Of Chapter 1

Chapter 1 addresses the overall GLAST Burst Monitor (GBM) System Safety and Mission Assurance (S&MA) Program requirements including applicable documents (Chapter 13) and document acronyms and glossary (Chapter 14). The GBM Contract Delivery Requirement List (CDRL) identifies those deliverables that are part of the S&MA Program for the GBM.

The CDRL data item description (DID) related to this chapter is:

| Description | DID No. | MAR Sections | Notes |
|---|---|---|---|
| Safety and Mission Assurance Program Plan (SSMAP) | 301 | 1.0, 1.1, 1.5, 2.0, 2.1, 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, 12.1 | The SSMAP may include the System Safety Program Plan (SSPP). |

Table 1-1: S&MA Management Program Deliverables

## 1.1 Overall Requirements

MSFC is required to plan and implement an organized System Safety and Mission Assurance Program that encompasses all flight hardware (designed and/or built by MSFC or their contractors or furnished by GSFC) from project initiation through launch operations to the extent necessary to assure the integrity and safety of flight items, the ground system that interfaces with flight equipment items, and all mission critical software. This plan will be documented in a System Safety and Mission Assurance Plan (SSMAP) in accordance with GBM CDRL, DID 301. This documented GBM S&MA Program will be applicable to the project and all associated contractors, subcontractors, and developers. If the GBM MAR conflicts with any MSFC, contractor, subcontractor, etc. document; the GLAST Project Manager and GBM Project Manager will mutually agree upon a resolution.

Although the GSFC GLAST S&MA Program's goal is to ensure the safety and success of the GLAST mission, since the GBM has been designated as "non mission critical" and since it is being provided to the GLAST Project by another NASA Center; the primary aim of the GSFC GBM S&MA Program will be to ensure that the GBM will have no negative effect on and can do no harm to personnel, ground support equipment, flight and ground software, the launch vehicle, the spacecraft/observatory, the Large Area Telescope or other payloads, or the GLAST Mission during any phase of the GBM and GLAST Programs including integration, test, pre-launch, launch, and on-orbit activities. This includes physical harm/damage, contamination, combustion/explosion, erroneous or accidental commands/signals, and all other possible negative effects. The responsibility for the GBM's successful mission (i.e., achieving its scientific goals) is the responsibility of MSFC; however, GSFC will maintain insight into and review/approval rights over the GBM S&MA Program to the extent necessary to satisfy the requirements of NASA review teams and mission safety criteria. These governing principles should be heeded when interpreting the contents of this document.

### 1.2 Applicable Documents (Chapter 13)

To the extent referenced herein, applicable portions of the documents listed in Chapter 14 form a part of this document. Unless otherwise noted, the current revision of each document is specified.

### 1.3 Acronyms And Glossary (Chapter 14)

Chapter 14 defines acronyms and terms as applied in this document.

### 1.4 Contract Delivery Requirements List (CDRL)

The CDRL contains DID's that describe data deliverable to the GSFC GLAST Project Office. The "DID numbers" cited in this document refer to the "CDRL numbers" listed on the DID's contained in the CDRL. Deliverables may be received/reviewed by GSFC personnel at either GSFC or at MSFC or their (sub)contractors as specified in the respective DID.

The following definitions apply with respect to assurance deliverables:

| | |
|---|---|
| Deliver for Approval: | Documents in this category require written GSFC approval prior to use. Resubmission requirements will be as specified in the letter(s) of disapproval. |
| Deliver for Information/Review: | Documents in this category require receipt by GSFC for the purpose of determining current program status, progress, and future planning requirements. When GSFC's evaluations reveal inadequacies, MSFC will be required to correct the documents. |

### 1.5 Ground Data Systems Assurance Requirements/Guidelines

Since the GBM Instrument Operations Center (IOC) will not perform any Level 0 processing, no ground data systems assurance requirements will be levied on the GBM IOC; however, the Ground Data System Requirements listed GSFC 433-MAR-0004 should be used as a guide for the S&MA requirements of the GBM IOC. Additionally, as noted in GBM CDRL, DID 301, the GBM SSMAP should include a description of the GBM IOC's (i.e., the ground data system's) assurance program which will be reviewed by GSFC for safety/do no harm implications. Note: If the GBM IOC is ever designed to perform Level 0 processing, GSFC and MSFC will revisit this issue since GSFC 433-MAR-0004 or a similar S&MA requirements document will be imposed on the GBM IOC at that time.

# CHAPTER 2. System Safety Requirements

## 2.0 Overview Of Chapter 2

Chapter 2 addresses the system safety requirements that are part of the GBM S&MA Program for the GBM instrument.

The DID's related to this chapter are:

| Item | DID No. | MAR Sections | Notes |
|---|---|---|---|
| System Safety Program Plan (SSPP) | 302 | 2.0, 2.1, 2.2 | May be incorporated into the SSMAP/PAIP. |
| Preliminary Hazard Analysis (PHA) | | | |
| Operating & Support Hazard Analysis (O&SHA) | | | |
| Hazard Control Verification Log | | | |
| Safety Assessment Report (SAR) | | | |
| Ground Operations Plan Inputs | | | |
| Safety Noncompliance Reports | | | |
| Orbital Debris Information for Mission Orbital Debris Analysis | 303 | 2.0, 2.3 | |

Table 2-1: System Safety Program Deliverables

## 2.1 System Safety Requirements

Flight hardware, software, and all ground support equipment (GSE) systems developers shall implement a system safety program in accordance with the requirements imposed by the appropriate launch range and the launch vehicle manufacturer or launch service provider. The requirements shall be tailored for the GLAST mission with the concurrence of the applicable launch range safety organization.

Marshall Space Flight Center shall prepare a SSPP that will describe their system safety program within their facility and, to the extent required, at the spacecraft integrator's facility and the launch facilities. (Refer to the GBM CDRL, DID 302.) The SSPP may be incorporated into the PAIP/SSMAP. (Refer to the GBM CDRL, DID 301.) The safety program shall be in accordance with the requirements of EWR 127-1 and KHB 1710.2D.

The following are mandatory compliance requirements for hardware and software to be launched out of the Eastern Range (ER) on any launch vehicle. The Project Manager shall ensure compliance with the requirements and certify to the launch range, in the form of the Safety Data Package, that all of the requirements have been met.

The top-level safety requirements documents for the GLAST launch are:

a. EWR 127-1, "Eastern and Western Range Safety Requirements" – This document defines range safety program responsibilities and authorities. It also delineates policies, processes, and approvals for all activities from the design concept through test, check-

out, assembly, and the launch of launch vehicles and payloads to orbital insertion or impact from or onto the ER. Additionally, it establishes minimum design, test, inspection, and data requirements for hazardous and safety critical launch vehicles, payloads, and ground support equipment, systems, and materials for ER users.

b. KHB 1710.2C, "Kennedy Space Center Safety Practices Handbook" – This document specifies and establishes safety policies and requirements that are essential during design, operation, and maintenance activities at KSC and other areas where KSC has jurisdiction.

Additionally, as appropriate, any testing performed at GSFC shall comply with the safety requirements contained in 5405-048-98, the Mechanical Systems Center Safety Manual.

Satisfactory compliance with the above requirements is required to gain payload and GSE access to the launch site and the subsequent launch.

Marshall Space Flight Center shall participate in project activities associated with compliance to NPD 8710.3, "NASA Policy for Limiting Orbital Debris Generation." Design and safety activities shall take into account the GBM's impact on the spacecraft's ability to conform to debris generation.

### 2.2 System Safety Deliverables

The GBM system safety deliverables will be prepared and delivered to GSFC in accordance with GBM CDRL, DID 302.

### 2.3 Orbital Debris Information For the Mission Orbital Debris Analysis

GBM orbital debris information will be prepared and delivered to GSFC for the Mission Orbital Debris Analysis in accordance with GBM CDRL, DID 303.

# CHAPTER 3. Technical Review Requirements

## 3.0 Overview Of Chapter 3

Chapter 3 addresses the technical review requirements that will be part of the S&MA Program for the GBM instrument.

The DID related to this chapter is:

| Items | DID No. | MAR Sections | Notes |
|---|---|---|---|
| GBM Systems Requirement Review (SRR) | 304 | 3.0, 3.1, 3.2, 3.5 | |
| GBM Preliminary Design Review (PDR) | | | |
| Software PDR (may be part of PDR) | | | |
| GBM Critical Design Review (CDR) | | | |
| Software CDR (may be part of CDR) | | | |
| GBM Pre-Environmental Review (PER) | | | |
| Mission SRR | | | MSFC's level of participation at these reviews will be determined by MSFC and GSFC when review agendas are prepared. Developer inputs will be blended into deliverables. |
| Mission PDR (MPDR) | | | |
| Mission CDR (MCDR) | | | |
| Observatory PER | | | |
| Observatory PSR | | | |
| Mission Operations Review (MOR) | | | |
| Operations Readiness Review (ORR) | | | |
| Launch Readiness Review (LRR) | | | |
| Safety Reviews | | | |
| Component/Subsystem Peer Reviews including Packaging Reviews | | | Reports only are deliverable. |
| Invitation to Peer/Packaging Review | | | |

Table 3-1: Technical Review Program Deliverables

## 3.1 General Requirements

MSFC will conduct a series of comprehensive system-level design reviews that will be conducted jointly with the GSFC Systems Review Office (SRO). These reviews will cover all aspects of flight and ground hardware, software, and operations for which MSFC has responsibility. (See Section 3.3.) In addition, MSFC will conduct a program of planned, scheduled and documented component and subsystem peer reviews of all aspects of his area of responsibility. (Refer to the GBM CDRL, DID 304.) The MSFC review chair and GSFC review chair will "co-chair" the design reviews although each co-chair will have their own review team, follow their own Center's review guidelines, and establish their own set of requests for information/action (RFI's/RFA's).

## 3.2 System Review Requirements

For each specified instrument-level review co-chaired by MSFC and GSFC review teams, MSFC will:

a. Develop and organize material for oral presentation to the GSFC/MSFC review teams. Copies of the presentation material will be available at each review.
b. Support splinter review meetings resulting from the major review.
c. Produce written responses to recommendations and action items resulting from the review.
d. Summarize, as appropriate, the results of MSFC reviews at the component and subsystem level.

Refer to the GBM CDRL, DID 304 for additional information.

## 3.3 System Review Program (SRP)

The GBM SRP will be coordinated by MSFC and GSFC so that it conforms to the review program guidelines for both Centers. The GSFC SRO Chief will develop this plan with the concurrence of MSFC and the GLAST Project Manager.

## 3.4 System Review Program Implementation

The GBM review program will be implemented as described in this section.

### 3.4.1 SYSTEM REVIEW PROGRAM (SRP)

The primary objective of a SRP is to enhance the probability of success of GSFC missions. This objective is achieved by bringing to bear on each GSFC-managed flight mission the cumulative knowledge of a team of engineers and scientists who have had extensive prior experience with the particular types of systems and functions involved. While the design review is technically oriented, proper consideration will be given to constraints operating on the mission. These reviews assure that each mission has the benefit of Center-wide experience gained on other missions.

### 3.4.2 SYSTEM REVIEW PLAN

The Chief of the SRO, in conjunction with the GLAST Project Manager and the MSFC review co-chair, will develop the GBM system review plan that will be documented in the project S&MA requirements. Each review chair (i.e., the GSFC and the MSFC review chair) will develop his/her own set of individual review requirements. The agenda for each review will fulfill the requirements of both teams. The Chief of the SRO may agree to waive the requirement for some reviews based primarily on considerations of system complexity, criticality, extent of technological design (e.g., state-of-the-art), previous flight history, mission objectives, and/or any mandated constraints. In summary:

a. GSFC's SRO will develop the review program plan with MSFC and GLAST Project concurrence
b. The MSFC review chair will develop individual review agendas with GSFC SRO and GLAST Project concurrence
c. Review requirements and pass/fail criteria will be independently developed by each review team (i.e., GSFC and MSFC) based on their Center's requirements/ guidelines

d. Each team will issue their own RFA's/RFI's during the review. The issuing team will be solely responsible for closing-out their RFA's/RFI's; however, information will be shared between teams and RFA's/RFI's will not be closed until both teams concur with responses.

### 3.4.3 THE SYSTEM REVIEW TEAM (SRT)

The GSFC SRT will include personnel experienced in subsystem design, systems engineering and integration, testing, and all other applicable disciplines. The GSFC review chair, in concert with the Project Manager, will appoint independent key technical experts as review team members. Personnel outside the Center may be invited as members of the SRT if their expertise will enhance the SRT. Simultaneously, the MSFC review chair will appoint their own independent review team based on similar criteria.

### 3.4.4 GLAST PROJECT/GBM REVIEWS

The GLAST/GBM reviews will be based upon an appropriate selection from the following system reviews:

a. System Requirements Review (SRR) - This review is keyed to the beginning of the design, assembly, and test phase to verify that the appropriate plans and requirement specifications are in place, well documented, and understood by all parties.

b. Preliminary Design Review (PDR) - This review occurs early in the design phase but prior to the manufacture of engineering hardware and the detailed design of associated software. Where applicable, it should include the results of test bedding, breadboard testing, and software prototyping. It should also include the status of the progress in complying with the launch range safety requirements. At the PDR, the flight hardware developer will identify and document all of the hazards associated with the flight hardware and software.

c. Critical Design Review (CDR) - This review will occur after the design has been completed but prior to the start of manufacturing flight components or software coding. It will emphasize implementations of design approaches as well as test plans for flight systems including the results of engineering model testing. MSFC is also required to present the status of the controls for the safety hazards presented in the PDR and the status of all presentations to the launch range.

d. Pre-Environmental Review (PER) - This review will occur prior to the start of environmental testing of the protoflight or flight system. The primary purpose of this review is to establish the readiness of the system for test and to evaluate the environmental test plans.

e. Pre-Shipment Review (PSR) - This review will take place prior to the GBM's shipment for integration with the spacecraft. Additionally, the spacecraft PSR will take place prior to the spacecraft's shipment to the launch range. The PSR will concentrate on system performance during qualification or acceptance testing. MSFC is required to present the status of the safety items listed in the validation tracking log, the status of deliverable documents to the launch range, and the status of presentations and any subsequent launch range issues or approvals prior to sending flight hardware to the range.

f. Mission Operations Review (MOR) - This mission operations-oriented review will normally take place prior to significant integration and test of the flight and ground systems. Its primary purpose is to present the overall plan for achieving mission operations readiness for spacecraft and instrument operations. Discussions will include plans and schedules for operations product development and validation, mission simulations, and launch rehearsals.

g. Operations Readiness Review (ORR) -This review will present the status of overall mission operations readiness and will occur approximately 2 months before launch. It will focus primarily on the end-to-end ground system, operations products and processes, and the operations team. The main goal is to demonstrate that the systems, products, processes, and people have been proven ready for launch from the operations perspective.

h. Launch Readiness Review (LRR) - This review will assess the overall readiness of the total system to support the flight objectives of the mission. The LRR is usually held at the launch site 2 to 3 days prior to launch.

#### 3.4.5 INSTRUMENT REVIEWS

The SRP for the GBM will consist of a SRR, PDR, CDR, PER, and PSR.

##### 3.4.5.1 Ground System SRP

In general, the SRP for new, project-unique ground system consists of a PDR and CDR. The GBM IOC may be reviewed during the mission-oriented reviews (SRR, MOR, FOR, and LRR). GBM personnel will attend and participate in these reviews to the extent necessary.

#### 3.4.6 SYSTEM REVIEW SCHEDULE

The system reviews will be conducted on a schedule jointly developed by the GSFC SRO Chief, the GLAST Project Manager, and the MSFC and GSFC review team chairs.

#### 3.4.7 SYSTEM SAFETY

The safety aspects of the systems being reviewed will be a normal consideration in the system evaluations conducted by the SRP. At each appropriate review, the project will demonstrate understanding of, and compliance with, the applicable launch range requirements; list any known noncompliances; and provide justification for any expected waiver conditions. In addition, the project will present the results of any safety reviews held with the Eastern Range.

### 3.5 MSFC Review Requirements

MSFC will implement a program of peer reviews for missions at the component and subsystem levels. The program should, as a minimum, consist of a PDR and CDR. In addition, packaging/peer reviews should be conducted on all electrical and electromechanical components in the flight system. The PDR and CDR should evaluate the ability of the component or subsystem to successfully perform its function under operating and environmental conditions during both testing and flight. The results of parts stress analyses and component packaging/peer reviews, including the results of associated tests and analyses, should be discussed at component PDR's and CDR's.

The packaging/peer reviews typically address:

a. Placement, mounting, and interconnection of EEE parts on circuit boards or substrates
b. Structural support and thermal accommodation of the boards and substrates and their interconnections in the component design
c. Provisions for protection of the parts and ease of inspection

MSFC reviews should be conducted by personnel who are not directly responsible for design of the hardware under review. GSFC requests the right to attend the peer reviews and requests 10 working days notification. The results of the reviews should be documented with the documentation made available for GSFC review at MSFC. Refer to the GBM CDRL, DID 304.)

# CHAPTER 4. Design Verification Requirements

Chapter 4 addresses the design verification requirements that shall be part of the S&MA Program for the GBM instrument. When reviewing the GBM verification documentation, GSFC reviewers shall do so to ensure the "safety" of thermal, structural, electrical, etc. interfaces. As noted in Section 1.1 of this document, the primary aim of the GSFC GBM S&MA Program is to ensure that the GBM will have no negative effect on and can do no harm to personnel, ground support equipment, flight and ground software, the launch vehicle, the spacecraft/observatory, the Large Area Telescope or other payloads, or the GLAST Mission during any phase of the GBM and GLAST Programs including integration, test, pre-launch, launch, and on-orbit activities. This includes physical harm/damage, contamination, combustion/explosion, erroneous or accidental commands/signals, and all other possible negative effects. It is the responsibility of MSFC's GBM S&MA Program to ensure the GBM's successful mission. This includes ensuring that the GBM can achieve its scientific goals through its performance verification program.

The CDRL DID's related to this chapter are:

| Items | DID No. | MAR Sections | Notes |
|---|---|---|---|
| GBM Verification Plan including: | 305 | 4.0, 4.2 | These documents will be prepared using MSFC requirements/ standards. |
| • Environmental Verification Plan | | | |
| • Performance Verification Matrix | | | |
| • Environmental Test Matrix (ETM) including the Environmental Test Tracking Matrix | | | |
| • Environmental Verification Specification | | | |
| Performance Verification Procedures | 306 | 4.0, 4.3 | |
| Verification Reports | 307 | 4.0, 4.4 | |
| GBM Performance Verification Reports | | | |

TABLE 4-1: DESIGN VERIFICATION PROGRAM DELIVERABLES

## 4.1 GENERAL

MSFC will conduct a verification program to ensure that the flight system meets the specified mission requirements. MSFC will provide adequate verification documentation to enable GSFC to ensure that the GBM can do no harm and is safe.

The "GEVS-SE for STS & ELV Payloads, Subsystems, and Components" may be used as a baseline guide for developing the verification program. The GEVS-SE document is available at http://arioch.gsfc.nasa.gov/302/verifhp.htm.

## 4.2 GBM Verification Plan

A GBM Verification Plan will be prepared per MSFC standards/requirements/formats. Hence, MSFC may submit a compilation of documents, rather than one consolidated plan, to fulfill GSFC's safety review needs. Per the GBM CDRL, DID 305, the plan will be reviewed by GSFC to ensure that the GBM interfaces (including thermal, structural, and electrical) are safe and that

the instrument can do no harm during any phase of the GLAST project/mission. As noted in DID 305, the plan will be submitted to GSFC for approval of the plan's aspects related to safety.

The GBM Verification Plan should typically include the following information/details that may be part of the plan or may referenced:

a. Environmental Verification Plan

This documentation will prescribe the tests and analyses that will collectively demonstrate that the hardware and software comply with the environmental verification requirements. The Environmental Verification Plan will provide the overall approach to accomplishing the environmental verification program. Limitations in the environmental verification program that preclude the verification by test of any system requirement are typically documented.

Because of the intended tailoring of the verification program, the preliminary plan should provide sufficient verification philosophy and detail to allow assessment of the program. A program philosophy is typically included. Examples of program philosophy are:

- All hardware shall be subjected to strength testing; however, if such is not possible, then qualification though analysis will be acceptable.
- Random vibration shall be performed at the subsystem or section level of assembly rather than at the component level.
- All instruments shall be subjected to acoustics tests and 3-axis sine and random vibration.
- All components shall be subjected to EMC tests.
- All flight hardware and flight spares shall see 8-thermal-vacuum cycles prior to integration on the spacecraft.

b. System Performance Verification Matrix

A System Performance Verification Matrix is prepared and maintained to show each specification requirement, the reference source (to the specific paragraph or line item), the method of compliance, applicable procedure references, results, report reference numbers, etc. This matrix is typically included in the system review data packages showing the current verification status as applicable.

c. Environmental Test Matrix (ETM)

As an adjunct to the system/environmental verification plan, an ETM is prepared to summarize all tests that will be performed on each component, each subsystem or instrument, and the payload. Its purpose is to provide a ready reference to the contents of the test program in order to prevent the deletion of a portion thereof without an alternative means of accomplishing the objectives. All flight hardware, spares and prototypes, when appropriate, are included in the ETM. The matrix is typically prepared in conjunction with the initial environmental verification plan and is updated as changes occur.

A complementary matrix is kept showing the tests that have been performed on each component, subsystem, instrument or payload (or other applicable level of assembly).

This includes tests performed on prototypes or engineering units used in the qualification program and indicates test results (i.e., pass/fail or malfunctions).

d. Environmental Verification Specification

An environmental verification specification is prepared as part of the System Performance Verification Plan or as a separate document. This specification defines the specific environmental parameters that each system element is subjected to either by test or analysis to demonstrate its ability to meet the mission performance requirements. Such things as payload peculiarities and interaction with the spacecraft and launch vehicle are taken into account.

### 4.3 GBM Verification Procedures

For each verification test activity conducted at the component, subsystem, or other appropriate levels of assembly, a verification procedure will be prepared that describes the configuration of the test article as well as how each test activity contained in the verification plan and specification will be implemented. GBM Verification Procedures will be delivered to GSFC for a safety-related review in accordance with GBM CDRL DID 306.) Procedures will be prepared using MSFC standards/requirements/formats.

Test procedures will contain details such as instrumentation monitoring, facility control sequences, test article functions, test parameters, pass/fail criteria, quality control checkpoints, data collection, and reporting requirements. The procedures will also address safety and contamination control provisions.

### 4.4 GBM Verification Reports

After each component, subsystem, payload, etc. verification activity has been completed, a report will be submitted to GSFC for a safety-related review in accordance with GBM CDRL DID 312. Reports will be prepared using MSFC standards/requirements/formats. For each analysis activity, the report will describe the degree to which the objectives were accomplished, how well the mathematical model was validated by related test data, and other such significant results. In addition, as-run verification procedures and all test and analysis data will be retained for review.

At the conclusion of the verification program, a final Performance Verification Report that compares the hardware/software specifications with the final verified measured/computed values will be submitted to GSFC for a safety-related review in accordance with GBM CDRL DID 307.This report will be developed and maintained “real-time” throughout the program. It will summarize the successful completion of verification activities and demonstrate compliance to applicable system performance specifications prior to integration of hardware/software into the next higher level of assembly.

### 4.5 Failure-Free Performance Testing

Prior to delivery to the spacecraft for integration, the GBM instrument will have demonstrated failure-free performance testing for at least the last 100 hours of operation. Major hardware or software changes during or after the verification program will invalidate any previous demonstration. CH-01

# CHAPTER 5. Electronic Packaging and Processes Requirements

## 5.0 Overview Of Chapter 5

Chapter 5 addresses the electronic packaging and processes requirements that shall be part of S&MA Program for the GBM instrument.

## 5.1 General Requirements

MSFC will plan and implement an Electronic Packaging and Processes Program to ensure that all electronic packaging technologies, processes, and workmanship activities selected and applied to the GBM program meet mission objectives for quality and reliability. GSFC will review this program only to ensure that GBM can “do no harm.”

## 5.2 Workmanship

MSFC will use, to the extent possible, the NASA preferred standards. Alternate workmanship standards may be used as long as they do not compromise GBM/GLAST safety. To ensure that the flight hardware meets safety requirements, MSFC may be requested to submit proposed specific alternate standards for a GSFC safety review. (Refer to Section 1.1 for an interpretation of “safe” with respect to deliverable reviews.)

# CHAPTER 6. Parts Requirements

## 6.0 Overview Of Chapter 6

Chapter 6 addresses the parts requirements that will be part of the System Safety and Mission Assurance Program for the GLAST Project.

The deliverable items (DID's) related to this chapter are:

| Item | DID No. | MAR Sections | Notes |
|---|---|---|---|
| Program Parts List (PPL) and As-Built Parts List (ABPL) | 308 | 6.0, 6.2 | |
| Alert/Advisory Disposition | 309 | 6.0, 6.3 | |

Table 6-1: Parts Program Deliverables

## 6.1 General Requirements

MSFC will be responsible for planning, implementing, and documenting an electrical, electronic, and electromechanical (EEE) parts program to ensure that all parts selected for use in flight hardware meet mission objectives for quality and reliability. This program will be described in the GBM SSMAP in accordance with the GBM CDRL, DID 301.

## 6.2 Parts Lists

MSFC will create and maintain a Program Parts List (PPL) for the duration of the project. The PPL will be submitted periodically to GSFC for safety reviews. (Refer to Section 1.1 for an interpretation of "safe" with respect to deliverable reviews.) Additionally, the As Built Parts List (ABPL) will be developed. Both the PPL and the ABPL will be delivered to GSFC in accordance with the GBM CDRL, DID 308.

## 6.3 Alerts

MSFC will be responsible for the review and disposition of NASA and Government Industry Data Exchange Program (GIDEP) Alerts and Advisories for applicability to the parts proposed for use or incorporated into the design. Alert applicability, impact, and corrective actions will be documented and reported to GSFC in accordance with the GBM CDRL, DID 309. Disposition information will be provided for GSFC information; however, GSFC must approve "use as is" responses to Alerts/Advisories with safety. Alert/Advisory dispositions will be provided directly to both the GLAST Systems Assurance Manager and the GSFC GLAST Parts Engineer.

# CHAPTER 7. Materials, Processes, and Lubrication Requirements

## 7.0 Overview Of Chapter 7

Chapter 7 addresses the materials, processes, and lubrication requirements that shall be part of the S&MA Program for the GBM instrument.

The DID related to this chapter is:

| Item | DID No. | MAR Sections | Notes |
|---|---|---|---|
| Materials, Lubrication, and Processes List Plus Related Documentation | 310 | 7.0, 7.2 | |

Table 7-1: Materials, Processes, and Lubrication Program Deliverables

## 7.1 General Requirements

MSFC will implement a comprehensive Materials and Processes Plan (M&PP) in accordance with MSFC standards and requirements. The M&PP will be documented in the SSMAP in accordance with GBM CDRL, DID 301. The M&PP will help ensure the success and safety of the mission by the appropriate selection, processing, inspection, and testing of the materials and lubricants employed to meet the GBM's operational requirements. The M&P Intercenter Agreement, dated August 1992, between MSFC's and GSFC's M&P groups will be utilized on the GBM M&PP. MSFC will provide:

a. M&P support for the GBM including real time M&P communication with, or reports to, GSFC who responsible for overall mission safety
b. Certify that all materials and lubricant requirements are met

Refer to Section 1.1 for an interpretation of "safe" and "safety" with respect to deliverable reviews and the GBM materials, lubrication, and processes program.

## 7.2 Materials, Lubrication, and Processes Lists

MSFC will prepare and submit Materials, Lubrication, and Processes Lists in accordance with the GBM CDRL, DID 313. This list will include information on polymeric materials and composites usage, inorganic materials and composites usage, lubrication usage, and material process utilization. Either MSFC or GSFC formats may be used. Materials with unconventional applications as well as noncompliant or nonstandard materials, processes, lubricants, etc. shall be highlighted on the Materials, Lubrication, and Processes Lists so they can be easily identified for a GSFC safety review. The list shall be submitted to GSFC for safety review as noted in Section 7.1 above.

### 7.3 Fasteners

As part of the materials list approval process, GSFC will review all flight fasteners for safety implications. Towards this end, MSFC will provide all information requested by GSFC to ensure its ability to concur with the flightworthiness of GBM flight fasteners. It is recommended that GBM fasteners comply with GSFC 541-PG-8072.1.2, “Goddard Space Flight Center Fastener Integrity Requirements” and document the GBM fastener program by preparing a Fastener Control Plan. Due to safety implications, GSFC retains the right to review all MSFC and supplier fastener information/data/ documentation.

Additionally, fasteners made of plain carbon or low alloy steel will be protected from corrosion. When plating is specified, it will be compatible with the space environment. On steels harder than RC 33, plating will be applied by a process that is not embrittling to the steel.

# CHAPTER 8. Reliability Requirements

## 8.0 Overview Of Chapter 8

Chapter 8 addresses reliability requirements that will be part of the S&MA Program for the GBM instrument.

The DID's related to this chapter are:

| Item | DID No. | MAR Sections | Notes |
|---|---|---|---|
| Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) | 311 | 8.0, 8.2.1 | |
| Worst Case Analyses (WCA) | 312 | 8.0, 8.2.2 | |

Table 8-1: Reliability Program Deliverables

## 8.1 General Requirements

MSFC will plan and implement a reliability program that interacts effectively with other project disciplines. MSFC will describe the GBM reliability program in the GBM SSMAP in accordance with the GBM CDRL, DID 301. As noted in Section 1.1, the reliability program and deliverables will be reviewed for safety implications.

## 8.2 Reliability Analyses

Reliability analyses will be performed concurrently with the GBM's design so that identified problem areas can be addressed and correction action taken (if required) in a timely manner.

### 8.2.1 Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)

A FMEA and CIL will be performed/prepared to identify system design concerns. At a minimum, failure modes should be assessed for each GBM component at the spacecraft/LAT interface levels. Each failure mode should be assigned a severity category based on the most severe effect caused by a failure. Mission phases (e.g., launch and on-orbit operation) should be addressed in the analysis. MSFC standards/requirements/formats will be utilized to prepare the GBM FMEA and CIL which will be delivered to GSFC in accordance with the GBM CDRL, DID 311.

### 8.2.2 Worst Case Analyses

Worst Case Analyses (WCA's) will be performed in accordance with MSFC standards/requirements/formats and provided to GSFC in accordance with the GBM CDRL, DID 312 for a safety/"negative impact" review. The results of any analyses will be presented at design reviews starting with the PDR.

# CHAPTER 9. Quality Assurance Requirements

## 9.0 Overview Of Chapter 9

Chapter 9 addresses the hardware quality assurance requirements that are part of the S&MA Program for the GBM instrument.

## 9.1 Quality of Management System

MSFC will have a Quality Management System that meets the minimum requirements of ANSI/ASQC Q9001-l994. This requirement will be flowed-down to hardware and software fabricators (etc.) unless waived by the GLAST Project Office. Upon request, MSFC's and their suppliers' quality manuals will be made available to GSFC for review at MSFC, electronically, or on a website. As noted in Section 1.1, any GSFC review would focus on "safety" or "do no harm" aspects of the GBM program. The GBM hardware quality program will be documented in the GBM SSMAP in accordance with the GBM CDRL, DID 301.

## 9.2 QA Management System Requirements Augmentation

The following requirements augment the identified portions of ANSI/ASQC Q9001-1994.

### 9.2.1 Q9001, SECTION 4.4.4

New on-orbit design of software and ground stations hardware will be in accordance with original system design specifications and validation processes.

### 9.2.2 Q9001, SECTION 4.6.3

MSFC's QA program will ensure flow-down to all major and critical suppliers of technical requirements and a process to verify compliance.

### 9.2.3 Q9001, SECTION 4.13.2

The reporting of failures will begin with the first power application at the lowest level of assembly or the first operation of a mechanical item. It will continue through formal acceptance of the GBM by the GLAST Project Office. Failures with potential mission safety implications will be reported immediately to the GSFC and the GLAST Systems Assurance Manager. Refer to Section 1.1 for clarification of GSFC's S&MA "safety" or "do no harm" focus.

# CHAPTER 10. Contamination Control Requirements

## 10.0 Overview Of Chapter 10

Chapter 10 addresses the contamination control requirements that form part of the S&MA Program for the GBM instrument.

The DID related to this chapter is:

| Item | DID No. | MAR Sections | NOTES |
|---|---|---|---|
| Contamination Control Plan (CCP) | 313 | 10.0, 10.1 | |

Table 10-1: Contamination Control Program Deliverable

## 10.1 Contamination Control Plan

MSFC will establish and implement a GBM contamination control program that will be described in the GBM Contamination Control Plan (CCP). The CCP will be prepared and delivered to GSFC in accordance with the GBM CDRL, DID 313.

## 10.2 Material Outgassing

All materials will be screened in accordance with ASTM E595. Additionally, a database for materials is available in NASA Reference Publication 1124, “Outgassing Data for Selecting Spacecraft Materials.” Individual material outgassing data will be established based on hardware’s operating conditions using ASTM E1559 where appropriate and reviewed by GSFC for “safety” implications as defined in Section 1.1.

## 10.3 Thermal Vacuum Bakeout

MSFC will perform thermal vacuum bakeouts and/or outgassing certification of all hardware using QCM’s. The parameters of such bakeouts (e.g., temperature, duration, and pressure) will be individualized depending on materials used, the fabrication environment, and the established contamination allowance.

## 10.4 Hardware Handling

MSFC will ensure electrostatic discharge (ESD) control and cleanroom standards are utilized during handling hardware. The GBM ESD program will be based on NASA-STD-8730.7 or ANSI ESD S20.20-1999. The contamination potential of material and equipment used in cleaning, handling, packaging, tent enclosures, shipping containers, bagging (e.g., anti-static film materials), and purging will be addressed.

# CHAPTER 11. Software Assurance Requirements

## 11.0 Overview Of Chapter 11

Chapter 11 addresses the software assurance requirements that are part of the S&MA Program for the GBM instrument.

## 11.1 General Requirements

MSFC will have a Software Quality Management System (SQMS) that is compliant with ANSI/ASQC Q9001. The SQMS will be applied to all software developed under this contract. The GBM software quality program will be documented in the GBM SSMAP in accordance with the GBM CDRL, DID 301. Refer to Section 1.1 for clarification of GSFC's "safety" focus on GBM activities including the SQMS.

## 11.2 Quality System Augmentations

MSFC's SQMS will be augmented as indicated below. The references listed below refer to sections of ISO/FDIS 9000-3:1997(E) that provide guidance on the development of a SQMS that is compliant with the ANSI/ASQC Q9001.

### 11.2.1 SECTION 4.1.3

A series of MSFC-presented formal software reviews that will be held and include independent software experts. The formal reviews will consist of, as a minimum, a Software SRR, PDR, CDR, Test Readiness Review (TRR), and Acceptance Review (AR). These reviews will be coordinated with the reviews defined in Chapter 3. MSFC will record minutes and action items during each review.

### 11.2.2 SECTION 4.8

MSFC will establish a Software Configuration Management (SCM) baseline after each formal of the software reviews discussed in Section 11.2.1. Thus, software products will be placed under configuration management immediately after the successful conclusion of each review. The GBM's SCM system will have a change classification and impact assessment process that results in Class 1 changes with potential safety implications being forwarded to GSFC prior to disposition. Class 1 changes are defined as those that affect system requirements, software requirements, system safety, reliability, cost, schedule, and external interfaces; however, refer to Section 1.1 for clarification on GSFC's safety concerns.

## 11.3 GFE Existing And Purchased Software

MSFC is responsible for GBM software (GFE, existing, or purchased) meeting the functional, performance, safety, and interface requirements placed upon it. MSFC is also responsible for ensuring that the software meets all applicable standards, and is responsible for securing a GSFC project waiver for any variation from those standards with safety implications. (Using Section 1.1's definition of "safety.") Any significant modification (i.e., a change to 20% of the lines of code) to any piece of the existing software will be subject to all of the provisions of the MSFC's SQMS and the provisions of this document.

### 11.4 Software Safety

If any software component is identified as “safety critical,” MSFC will conduct a software safety program that complies with NASA-STD-8719.13A, “Software Safety,” on that component. (Note: “Safety” is used in NASA’s traditional sense in this section.)

# CHAPTER 12. Risk Management Requirements

## 12.0 Overview Of Chapter 12

Chapter 12 addresses the risk management requirements that are part of the S&MA Program for the GBM instrument. GSFC's review emphasis will be on safety, as noted in Section 1.1, since MSFC has responsibility for the GBM's performance.

## 12.1 General Requirements

Risk Management is a requirement established by the NPG 7120.5A, "NASA Program and Project Management Processes and Requirements." The GBM Risk Management Plan will be documented in the GBM SSMAP in accordance with the GBM CDRL, DID 301. Risk Management applies to all software and hardware products and processes (flight and ground) to identify, analyze, track, and control risks and well as plan mitigation actions.

Risk status will be presented during reviews and addressed in technical review reports. GSFC's review emphasis will be on the safety implications of risks and their proposed mitigation plans.

# CHAPTER 13. Applicable Documents List

| DOCUMENT DESIGNATION | DOCUMENT TITLE |
|---|---|
| ANSI/ASQC Q9001-1994 | Model for Quality Assurance in Design, Development, Production, Installation, and Servicing |
| ANSI/ASQC Q9000-3 | Quality Management and Quality Assurance Standards |
| ANSI/IPC-A-600 | Acceptance Criteria for Printed Wiring Boards |
| ANSI/IPC-D-275 | Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies |
| ANSI/IPC-HF 318 | Microwave End Product Board Inspection and Test |
| ANSI/IPC-RB-276 | Qualification and Performance Specification for Rigid Printed Boards |
| ASTM E-595 | Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment |
| EWR 127-1 | Eastern and Western Range Safety Requirements |
| KHB 1710.2D | Kennedy Space Center Safety Practices Handbook |
| NPD 8710.3 | NASA Policy for Limiting Orbital Debris Generation |
| GEVS-SE | General Environmental Verification Specification for STS and ELV Payloads, Subsystems, and Components |
| 5405-048-98 | Mechanical Systems Center Safety Manual |
| GSFC 311-INST-001 | Instructions for EEE Parts Selection, Screening, and Qualification |
| GSFC S-312-P003 | Procurement Specification for Rigid Printed Boards for Space Applications and Other High Reliability Uses |
| GSFC 433-CDRL-0001 | GBM Contract Deliverables Requirements List (CDRL) |
| GSFC 433-SPEC-0001 | GLAST Mission System Specification |
| GSFC 541-PG-8072.1.2 | Goddard Space Flight Center Fastener Integrity Requirements |
| GSFC PPL-21, Notice 1 | Goddard Space Flight Center Preferred Parts List |
| MIL-STD 1629A | Procedures for Performing a Failure Mode Effects and Criticality Analysis |
| MSFC CR 5320.9 | Payload and Experiment Failure Mode Effects Analysis and Critical Items List Ground Rules |
| MSFC-HDBK-527 | Material Selection List for Space Hardware Systems |
| MSFC-SPEC-522 | Design Criteria for Controlling Stress Corrosion Cracking |
| NASA Reference Publication (RP) 1124 | Outgassing Data for Selecting Spacecraft Materials |
| NASA RP-1161 | Evaluation of Multi-layer Printed Wiring Boards by Metallographic Techniques |
| NHB 8060.1 | Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments That Support Combustion |
| NASA-STD-8719.13A | Software Safety |
| NSS 1740.14 | Guidelines and Assessment Procedures for Limiting Orbital Debris |
| S-302-89-01 | Procedures for Performing a Failure Mode and Effects Analysis (FMEA) |
| S-311-M-70 | Specification for Destructive Physical Analysis |

## 14.1 Acronyms

| | |
|---|---|
| ABPL | As-Built Parts List |
| ANSI | American National Standards Institute |
| AR | Acceptance Review |
| ASQC | American Society for Quality Control |
| ASIC | Application Specific Integrated Circuits |
| BOL | Beginning of Life |
| CCP | Contamination Control Plan |
| CDR | Critical Design Review |
| CDRL | Contract Delivery Requirements List |
| CIL | Critical Items List |
| CPT | Comprehensive Performance Test |
| CVCM | Collected Volatile Condensable Mass |
| DID | Data Item Description |
| DoD | Department of Defense |
| DPA | Destructive Physical Analysis |
| DRP | Design Review Program |
| DRT | Design Review Team |
| EEE | Electrical, Electronic, and Electromechanical |
| ELV | Expendable Launch Vehicle |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| EOL | End of Life |
| ESD | Electrostatic Discharge |
| FMEA | Failure Modes and Effects Analysis |
| FOR | Flight Operations Review |
| GEVS | General Environmental Verification Specification |
| GEVS-SE | General Environmental Verification Specification for STS & ELV Payloads, Subsystems, and Components |
| GFE | Government-Furnished Equipment |
| GIA | Government Inspection Agency |
| GIDEP | Government Industry Data Exchange Program |
| GMI | Goddard Management Instruction |
| GSE | Ground Support Equipment |
| GSFC | Goddard Space Flight Center |
| IAC | Independent Assurance Contractor |
| ICD | Interface Control Document |
| IRD | (GBM – Spacecraft) Interface Requirements Document |
| IRT | Independent Review Team |
| JPL | Jet Propulsion Laboratory |
| JSC | Johnson Space Center |
| LAT | Large Area Telescope |
| LPT | Limited Performance Test |
| LRR | Launch Readiness Review |
| M&P | Materials and Process |
| M&PP | Materials and Process Plan |
| MAG | Mission Assurance Guidelines |
| MCDR | Mission Critical Design Review |

| | |
|---|---|
| MCM | Multi-Chip Module |
| MPDR | Mission Preliminary Design Review |
| MO&DSD | Mission Operations and Data Systems Directorate |
| MOR | Mission Operations Review |
| MSFC | Marshall Space Flight Center |
| MSR | Management Status Report |
| MUA | Materials Usage Agreement |
| NAS | NASA Assurance Standard |
| NASA | National Aeronautics and Space Administration |
| Nascom | NASA Communications Network |
| NHB | NASA Handbook |
| OSSMA | (GSFC) Office of Systems Safety and Mission Assurance |
| PAPL | Project Approved Parts List |
| PCB | Parts Control Board |
| PCP | Parts Control Plan |
| PDR | Preliminary Design Review |
| PER | Pre-Environmental Review |
| PFR | Problem/Failure Report |
| PI | Principal Investigator |
| PIL | Parts Identification List |
| POCC | Payload Operations Control Center |
| PPL | Preferred Parts List |
| PRA | Probabilistic Risk Assessment |
| PSR | Pre-Shipment Review |
| PWB | Printed Wiring Board |
| QCM | Quartz Crystal Microbalance |
| RD | Recommended Documentation |
| RFA | Request for Action |
| RFI | Request for Information |
| RFP | Request for Proposal |
| RH | Relative Humidity |
| S&MA | (System) Safety and Mission Assurance |
| SAM | (GSFC GLAST) Systems Assurance Manager |
| SCC | Stress Corrosion Cracking |
| SCD | Source Control Drawing |
| SCM | Software Configuration Management |
| SCR | System Concept Review |
| SSMAP | System Safety and Mission Assurance Plan |
| SOCC | Simulations Operations Control Center |
| SOW | Statement of Work |
| SQMS | Software Quality Management System |
| SRO | (GSFC) Systems Review Office |
| SRP | System Review Plan |
| SRR | Software Requirements Review |
| SRT | System Review Team |
| TML | Total Mass Loss |
| TR | Torque Ratio |
| TRR | Test Readiness Review |
| WCA | Worst Case Analysis |

## 14.2 Definitions

The following definitions apply within the context of this document:

**Acceptance Tests**: The validation process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies and, normally, to provide the basis for delivery of an item under terms of a contract.

**Assembly**: See Level of Assembly.

**Audit**: A review of the developer's, contractor's or subcontractor's documentation or hardware to verify that it complies with project requirements.

**Collected Volatile Condensable Material (CVCM):** The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific constant temperature for a specified time.

**Component**: See Level of Assembly.

**Configuration:** The functional and physical characteristics of the payload and all its integral parts, assemblies and systems that are capable of fulfilling the fit, form and functional requirements defined by performance specifications and engineering drawings.

**Configuration Control**: The systematic evaluation, coordination, and formal approval/ disapproval of proposed changes and implementation of all approved changes to the design and production of an item the configuration of which has been formally approved by the contractor or by the purchaser, or both.

**Configuration Management (CM)**: The systematic control and evaluation of all changes to baseline documentation and subsequent changes to that documentation which define the original scope of effort to be accomplished (contract and reference documentation) and the systematic control, identification, status accounting and verification of all configuration items.

**Contamination:** The presence of materials of molecular or particulate nature that degrade the performance of hardware.

**Derating**: The reduction of the applied load (or rating) of a device to improve reliability or to permit operation at high ambient temperatures.

**Design Specification**: Generic designation for a specification that describes functional and physical requirements for an article, usually at the component level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects the end-item specifications serve all the purposes of design specifications for the contract end-items. Design specifications provide the basis for technical and engineering management control.

**Designated Representative**: An individual (such as a NASA plant representative), firm (such as assessment contractor), Department of Defense (DOD) plant representative, or other government representative designated and authorized by NASA to perform a specific function for NASA. As related to the contractor's effort, this may include evaluation, assessment, design review, participation, and review/approval of certain documents or actions.

**Destructive Physical Analysis (DPA)**: An internal destructive examination of a finished part or device to assess design, workmanship, assembly, and any other processing associated with fabrication of the part.

**Design Qualification Tests**: Tests intended to demonstrate that the test item will function within performance specifications under simulated conditions more severe than those expected

from ground handling, launch, and orbital operations. Their purpose is to uncover deficiencies in design and method of manufacture. They are not intended to exceed design safety margins or to introduce unrealistic modes of failure. The design qualification tests may be to either "prototype" or "protoflight" test levels.

**Discrepancy**: See Nonconformance

**Electromagnetic Compatibility (EMC)**: The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

**Electromagnetic Interference (EMI)**: Electromagnetic energy that interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

**Electromagnetic Susceptibility**: Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

**End-to-End Tests**: Tests performed on the integrated ground and flight system, including all elements of the payload, its control, stimulation, communications, and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.

**Failure**: A departure from specification that is discovered in the functioning or operation of the hardware or software. See nonconformance.

**Failure Free Hours of Operation**: The number of consecutive hours of operation without failure the hardware and/or software (as appropriate) accumulated without an operating problem or anomaly since the last major hardware/software change (as appropriate), problem, or anomaly. Hours may be accumulated over various stages of hardware integration.

**Failure Modes and Effects Analysis (FMEA)**: A procedure by which each credible failure mode of each item from a low indenture level to the highest is analyzed to determine the effects on the system and to classify each potential failure mode in accordance with the severity of its effect.

**Flight Acceptance**: See Acceptance Tests.

**Fracture Control Program**: A systematic project activity to ensure that a payload intended for flight has sufficient structural integrity as to present no critical or catastrophic hazard. Also to ensure quality of performance in the structural area for any payload (spacecraft) project. Central to the program is fracture control analysis, which includes the concepts of fail-safe and safe-life, defined as follows:

**Fail-safe**: Ensures that a structural element, because of structural redundancy, will not cause collapse of the remaining structure or have any detrimental effects on mission performance.

**Safe-life**: Ensures that the largest flaw that could remain undetected after non-destructive examination would not grow to failure during the mission.

**Functional Tests**: The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.

**Hardware**: As used in this document, there are two major categories of hardware as follows:

**Prototype Hardware**: Hardware of a new design which is subjected to a design qualification test program. It is not intended for flight.

**Flight Hardware**: Hardware to be used operationally in space. It includes the following subsets:

1. **Protoflight Hardware**: Flight hardware of a new design; it is subject to a qualification test program that combines elements of prototype and flight acceptance validation; that is, the application of design qualification test levels and duration of flight acceptance tests.

2. **Follow-On Hardware**: Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is subject to a flight acceptance test program.
3. **Spare Hardware**: Hardware the design of which has been proven in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.
4. **Re-flight Hardware**: Flight hardware that has been used operationally in space and is to be reused in the same way; the validation program to which it is subject depends on its past performance, current status, and the upcoming mission.

**Inspection**: The process of measuring, examining, gauging, or otherwise comparing an article or service with specified requirements.

**Instrument**: See Level of Assembly.

**Level of Assembly**: The environmental test requirements of GEVS generally start at the component or unit level assembly and continue hardware/software build through the system level (referred to in GEVS as the payload or spacecraft level). The assurance program includes the part level. Validation testing may also include testing at the assembly and subassembly levels of assembly; for test record keeping these levels are combined into a "subassembly" level. The validation program continues through launch, and on-orbit performance. The following levels of assembly are used for describing test and analysis configurations:

1. **Part**: A hardware element that is not normally subject to further subdivision or disassembly without destruction of design use. Examples include resistor, integrated circuit, relay, connector, bolt, and gaskets.
2. **Subassembly**: A subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.
3. **Assembly**: A functional subdivision of a component consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power amplifier and gyroscope.
4. **Component or Unit**: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are electronic box, transmitter, gyro package, actuator, motor, and battery. For the purposes of this document, "component" and "unit" are used interchangeably.
5. **Section**: A structurally integrated set of components and integrating hardware that form a subdivision of a subsystem, module, etc. A section forms a testable level of assembly, such as components/units mounted into a structural mounting tray or panel-like assembly, or components that are stacked.
6. **Subsystem**: A functional subdivision of a payload consisting of two or more components. Examples are structural, attitude control, electrical power, and communication subsystems. Also included as subsystems of the payload are the science instruments or experiments.
7. **Instrument**: A spacecraft subsystem consisting of sensors and associated hardware for making measurements or observations in space. For the purposes of this document, an instrument is considered a subsystem (of the spacecraft).
8. **Module**: A major subdivision of the payload that is viewed as a physical and functional entity for the purposes of analysis, manufacturing, testing, and record keeping. Examples include spacecraft bus, science payload, and upper stage vehicle.
9. **Observatory**: See Spacecraft.

10. **Payload**: An integrated assemblage of modules, subsystems, etc., designed to perform a specified mission in space. For the purposes of this document, "payload" and "spacecraft" are used interchangeably. Other terms used to designate this level of assembly are Laboratory, Observatory, and satellite.
11. **Spacecraft**: See Payload. Other terms used to designate this level of assembly are laboratory, observatory, and satellite.

**Limit Level**: The maximum expected flight.

**Limited Life Items**: Spaceflight hardware (1) that has an expected failure-free life that is less than the projected mission life, when considering cumulative ground operation, storage and on-orbit operation, (2) limited shelf life material used to fabricate flight hardware.

**Margin**: The amount by which hardware capability exceeds mission requirements

**Module**: See Level of Assembly.

**Monitor**: To keep track of the progress of a performance assurance activity; the monitor need not be present at the scene during the entire course of the activity, but he will review resulting data or other associated documentation (see Witness).

**Nonconformance**: A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality assurance, nonconformances fall into two categories--discrepancies and failures. A discrepancy is a departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating. A failure is a departure from specification that is discovered in the functioning or operation of the hardware or software.

**Offgassing**: The emanation of volatile matter of any kind from materials into a manned pressurized volume.

**Outgassing**: The emanation of volatile materials under vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces.

**Part**: See Level of Assembly.

**Payload**: See Level of Assembly.

**Performance Operating Time/Hours**: The number of hours or amount of time that the hardware or software (as appropriated) was operated at any level of assembly or at a particular level of assembly as defined.

**Performance Validation**: Determination by test, analysis, or a combination of the two that the payload element can operate as intended in a particular mission; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for flight operations.

**Protoflight Testing**: See Hardware.

**Prototype Testing**: See Hardware.

**Qualification**: See Design Qualification Tests.

**Redundancy (of design)**: The use of more than one independent means of accomplishing a given function.

**Repair**: A corrective maintenance action performed as a result of a failure so as to restore an item to op within specified limits.

**Rework**: Return for completion of operations (complete to drawing). The article is to be reprocessed to conform to the original specifications or drawings.

**Section**: See Level of Assembly.

**Similarity, Validation By**: A procedure of comparing an item to a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design-differences are insignificant, environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.

**Single Point Failure (SPF)**: A single element of hardware the failure of which would result in loss of mission objectives, hardware, or crew, as defined for the specific application or project for which a single point failure analysis is performed.

**Spacecraft**: See Level of Assembly.

**Subassembly**: See Level of Assembly.

**Subsystem**: See Level of Assembly.

**Temperature Cycle**: A transition from some initial temperature condition to temperature stabilization at one extreme and then to temperature stabilization at the opposite extreme and returning to the initial temperature condition.

**Temperature Stabilization**: The condition that exists when the rate of change of temperatures has decreased to the point where the test item may be expected to remain within the specified test tolerance for the necessary duration or where further change is considered acceptable.

**Thermal Balance Test**: A test conducted to verify the adequacy of the thermal model, the adequacy of the thermal design, and the capability of the thermal control system to maintain thermal conditions within established mission limits.

**Thermal-Vacuum Test**: A test conducted to demonstrate the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test, including the gradient shifts induced by cycling between temperature extremes, can also uncover latent defects in design, parts, and workmanship.

**Torque Margin**: Torque margin is equal to the torque ratio minus one.

**Torque Ratio**: Torque ratio is a measure of the degree to which the torque available to accomplish a mechanical function exceeds the torque required.

**Total Mass Loss (TML)**: Total mass of material outgassed from a specimen that is maintained at a specified constant temperature and operating pressure for a specified time.

**Unit**: See Level of Assembly.

**Vibroacoustics**: An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration.

**Workmanship Tests**: Tests performed during the environmental validation program to verify adequate workmanship in the construction of a test item. It is often necessary to impose stresses beyond those predicted for the mission in order to uncover defects. Thus random vibration tests are conducted specifically to detect bad solder joints, loose or missing fasteners, improperly mounted parts, etc. Cycling between temperature extremes during thermal-vacuum testing and the presence of electromagnetic interference during EMC testing can also reveal the lack of proper construction and adequate workmanship.

**Witness**: A personal, on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements (see Monitor).

**Safety and Mission Assurance Deliverables**

| CDRL NO. | DESCRIPTION | DUE DATE, MATURITY | QT | DIS | CA |
|---|---|---|---|---|---|
| 301 | System Safety and Mission Assurance Plan (SSSMAP) | 3 Months Prior to CDR, Final<br>As Generated, Revisions | E | A | I* |
| 302 | System Safety Program Plan (SSPP) | 3 Months Prior to CDR, Final<br>As Generated, Revisions | E | B | A |
| | Preliminary Hazard Analysis (PHA) | 3 Months Prior to CDR, Preliminary<br>6 Months After CDR, Update | E | A | A |
| | Safety Noncompliance Reports | As Generated, Final | E | B | A |
| | Hazards Verification Log | In Support of Spacecraft Contractor's MSPSP Schedule<br>As Generated to Document Hazard Analyses, Initial<br>As Warranted by Analyses, Updates | E | B | A |
| | Safety Assessment Report (SAR) | In Support of Spacecraft Contractor's MSPSP Schedule | E | B | A |
| | Ground Operations Plan (GOP) Inputs (to Spacecraft Contractor) | 45 Days Prior to the MCDR, Initial<br>45 Days Prior to Observatory Shipment to Range, Final | E | B | A |
| | Hazardous and Safety Critical Procedures | 15 Days Prior to the First Run of Each Procedure, Final | E | B | A |
| 303 | Orbital Debris Information for Mission Orbital Debris Analysis | In Support of the Mission Orbital Debris Analysis Schedule<br>3 Months Prior to MPDR, Initial<br>3 Months Prior to MCDR, Final<br>As Generated, Revisions | E | B | A |
| 304 | Technical Reviews | For GSFC Chaired/Co-Chaired Reviews Only:<br>Agenda – 30 Days Prior to Review, Final<br>Presentation Material – 10 Days Prior to Review, Final<br>Responses to GSFC RFA's - Per Schedule Established at/for Review, Final<br>MSFC-Generated RID's – 7 Days After Review, Final<br>Close-Out Reports for MSFC-Generated RID's – As Generated, Final | E | B | A<br>I<br><br>A<br>I<br>I |

**Safety and Mission Assurance Deliverables**

| CDRL NO. | DESCRIPTION | DUE DATE, MATURITY | QT | DIS | CA |
|---|---|---|---|---|---|
| 305 | GBM Verification Plan including the:<br>▪ Environmental Verification Plan<br>▪ System Performance Verification Matrix<br>▪ Environmental Test Matrix (ETM)<br>▪ Environmental Verification Specification | 3 Months Prior to CDR, Preliminary<br>At the CDR, Final<br>As Generated, Updates | E | A | A* |
| 306 | GBM Verification Procedures | Audit As Required 30 Days Prior to the Start of Testing | E | B | I* |
| 307 | GBM Verification Reports | 72 Hours After Testing, Preliminary<br>30 Days After Verification Activity, Final | E | B | I |
| | Performance Verification Report | At the CDR, Preliminary<br>30 Days Following On-Orbit Check Out, Final | E | B | I |
| 308 | Program Parts List (PPL) and As Built Parts List (ABPL) | PPL – 3 Months After to PDR, Initial<br>30 Days Prior to CDR, Final<br>As Generated, Revisions<br>ABPL - 30 Days Prior to Hardware Shipment, Final) | E | A | I* |
| 309 | Alert/Advisory Disposition | 1 Month After Receipt of Alert/Advisory from GSFC, Final<br>"Use As Is" Dispositions With Safety Implications, Final | E | B | I*<br>A |
| 310 | Materials, Lubrication, and Processes Lists Plus Related Documentation | As Designed - 3 Months Prior to CDR, Preliminary<br>6 Months After to CDR, Final<br>As Generated, Updates<br>As Built - 30 Days Prior to Hardware Acceptance, Final<br>As Generated, Updates<br>Information on Material Waivers, Fasteners, Processes, Raw Materials, Etc. – Upon Request, Final | E | A | I* |
| 311 | Failure Mode and Effects Analysis (FMEA) and Critical Items List (CIL) | 3 Months Prior to CDR, Preliminary<br>3 Months After CDR, Final<br>As Generated, Updates | E | A | I* |

| CDRL NO. | DESCRIPTION | DUE DATE, MATURITY | QT | DIS | CA |
|---|---|---|---|---|---|
| 312 | Worst Case Analysis (WCA) | 3 Months Prior to CDR, Initial<br>3 Months After CDR, Final<br>As Generated, Updates | E | A | I*<br><br> |
| 313 | Contamination Control Plan | 3 Months Prior to the CDR, Initial<br>1 Month After the CDR, Final<br>As Generated, Updates | E | A | I<br>A<br>A |

**Safety And Mission Assurance Program Plan (SSMAP)**

| Title:<br>System Safety and Mission Assurance Plan (SSMAP) | CDRL No.:<br>301 |
|---|---|
| Reference:<br>MAR Sections 1.0, 1.1, 1.5, 2.0, 2.1, 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, and 12.1 | |
| Use:<br>Detail the MSFC's system safety and mission assurance program for the GBM | |
| Related Documents<br>None | |
| Place/time/purpose of delivery:<br>Delivery is due to GSFC 3 months prior to CDR for review of safety-related aspects of GBM S&MA Program. Any subsequent revisions will also be submitted to GSFC for a similar review. | |
| Preparation Information:<br><br>The SSMAP (or an accumulation of equivalent GBM documents will include the details of the MSFC's plans for implementing the following S&MA-related programs. This documentation should be prepared in accordance with MSFC standards/requirements/formats.<br><br>a) Technical Review<br>b) Design Verification<br>c) Electronic Packaging and Processes<br>d) Parts<br>e) Materials, Processes, and Lubrication<br>f) Reliability<br>g) Quality Assurance<br>h) Contamination Control<br>i) Software Assurance<br>j) Risk Management<br>k) Ground Data Systems Assurance<br><br>Note: Since the system safety program will to be covered in the GBM's System Safety Program Plan, it is not necessary to include them in the SSMAP. | |

**System Safety Documentation**

| Title:<br>System Safety Documentation | CDRL No.:<br>302 |
|---|---|
| Reference:<br>MAR Sections 2.0, 2.1, and 2.2 | |
| Use:<br>To provide information to verify that the GBM and associated flight and ground hardware, software, and procedures are safe. | |
| Related Documents:<br>EWR 127-1 and KHB 1710.2D<br>NASA GB 1740.13.96, "NASA Guidebook for Safety Critical Software" | |
| Place/Time/Purpose of Delivery: All deliverables and (whether specifically noted below or not) any/all revisions to deliverables shall be delivered to GSFC for approval.<br>SSPP - Deliver to GSFC with, or as part of, the SSMAP, 3 months prior to the CDR.<br>PHA - Deliver to GSFC 3 months prior to the CDR with an update due 6 months after CDR.<br>Safety Non-Compliance Reports - Generate as noncompliances are revealed/discovered and submit to GSFC.<br>Hazards Verification Log - Make available, after GSFC has approved log, to Range Safety upon request in support of the spacecraft contractor's MSPSP submittal schedule. The log is to be generated as required to document hazard analyses. It will be updated as warranted by the analyses.<br>SAR – Deliver to GSFC in support of the spacecraft contractor's MSPSP submittal schedule.<br>GOP – After GSFC has approved the log, provide initial input to Range Safety 45 days prior to the MCDR respectively with final submittal 45 days prior to observatory shipment to the Range. GOP inputs may be included in the SAR if so requested by the spacecraft contractor.<br>Hazardous and Safety Critical Procedures – Deliver to GSFC 15 days prior to the first run of each procedure.<br>O&SHA – Deliver initial draft to GSFC 30 days prior to the CDR with an update due 120 days prior to launch to support final MSPSP delivery to the Range. | |
| Preparation Information:<br><br>As part of the GBM Safety Program, related safety documentation shall and Launch Range approval of all safety-related documentation is required prior to launch. All documentation shall meet the requirements of EWR-127-1 and other pertinent NASA/KSC/GSFC safety specifications/standards. Document shall be delivered to GSFC and/or the spacecraft contractor as specified in this DID, the CDRL, and the GBM MAR.<br><br>• System Safety Program Plan (SSPP) prepare per EWR 127-1, Appendix 1B<br>• Preliminary Hazard Analysis (PHA) prepare per EWR 127-1, Appendix 1B<br>• Safety Non-Compliance Reports prepare per EWR 127-1, Appendix 1C<br>• Hazards Control Verification Log prepare per EWR 127-1, Appendix 1B.1<br>• Safety Assessment Report (SAR) prepare per EWR 127-1, Appendix 6A<br>• Ground Operations Plan (GOP) including Hazardous and Safety Critical Procedures prepared per EWR 127-1, Appendix 6A and 6B<br>• Operating and Support Hazard Analysis (O&SHA) prepare per EWR 127-1, Appendix 1B<br><br>A single closed-loop tracking system shall be implemented to track hazards and their controls, providing an audit trail of hazard resolution. The close-out of each hazard control shall be ensured/verified prior to launch. | |

**Orbital Debris Information For Mission Orbital Debris Analysis**

| Title:<br>Orbital Debris Information for Mission Orbital Debris Analysis | CDRL No.:<br>303 |
|---|---|
| Reference:<br>MAR Sections 2.0 and 2.3 | |
| Use:<br>To limit the generation of orbital debris. This analysis is required to demonstrate compliance with the requirements of NPD 8710.3 and NSS 1740.14 | |
| Related Documents:<br>NASA Directive NP, "NASA Policy for Limiting Orbital Debris Generation"<br>(http://nodis.hq.nasa.gov/Library/Directives/NASA-WIDE/Policies/Program_Management/N_PD_8710_3.html)<br>NSS 1740.14, "Guidelines and Assessment Procedures for Limiting Orbital Debris" | |
| Place/Time/Purpose of Delivery:<br>GBM orbital debris information will be provided in support of the spacecraft contractor's Mission Orbital Debris Analysis schedule. The initial input will be provided 3 months prior to the MPDR while the final input will be provided 3 months prior to the MCDR. All revisions will be provided for GSFC approval. | |
| Preparation Information:<br><br>GBM orbital debris information will be prepared for incorporation into the mission orbital debris analysis shall be conducted and documented to assess orbital debris generation potential and debris mitigation options.<br><br>The GBM team should note that the mission analysis will include:<br><br>a. The potential for orbital debris generation in both nominal operation and malfunction conditions including malfunctions during launch<br>b. The potential for orbital debris generation due to on-orbit impact with existing space debris (natural or human generated) or other orbiting space systems<br>c. The debris casualty area generated by the observatory, without a propulsion system, during an uncontrolled re-entry. (If the observatory debris casualty area exceeds 6.8 meters squared, include recommendations for alternative materials and design that may reduce the debris casualty area.)<br>d. The debris field generated by the observatory, with a propulsion system, during a controlled re-entry<br>e. Survival of re-entering space system components after post-mission disposal<br><br>Note: Orbital Debris Assessment Services will be available from JSC using ORSAT. | |

**Technical Review Information**

| Title:<br>Technical Review Information | CDRL No.:<br>304 |
|---|---|
| Reference:<br>MAR Sections 3.0, 3.1, 3.2, and 3.5 | |
| Use:<br>Provide review agenda and presentation material prior to the review. Provide copies of MSFC-generated RID's and their subsequent close-out reports. Provide responses to GSFC Requests for Action (RFA's), | |
| Related Documents:<br>None | |
| Place/Time/Purpose of Delivery:<br>• Provide review agenda 30 days prior to GSFC co-chaired review for GSFC approval.<br>• Provide review presentation materials 10 days prior to GSFC co-chaired review for GSFC information. This will include the reviews listed in GBM MAR Section 3.<br>• Provide responses to GSFC RFA's, per the schedule established at/for the review, for GSFC approval.<br>• Provide copies of MSFC-generated RID's for GSFC information within 7 days after the review.<br>• Provide close-out reports for MSFC-generated RID's for GSFC information as generated. | |
| Preparation Information:<br><br>Agendas, presentation materials, MSFC-generated RID's, and MSFC RID close-out reports will be prepared using MSFC standards/requirements/formats. Information may be delivered to GSFC via electronic mail or a website.<br><br>Responses to GSFC RFA's will be prepared using a mutually agreeable format. | |

**GBM Verification Plan**

| Title:<br>GBM Verification Plan | CDRL No.:<br>305 |
|---|---|
| Reference:<br>MAR Sections 4.0 and 4.2 | |
| Use:<br>Provides the overall approach for accomplishing the verification program. Defines the specific tests, analyses, calibrations, alignments, etc. that will demonstrate that the hardware complies with the mission requirements | |
| Related Documents<br>None | |
| Place/Time/Purpose of Delivery:<br>The preliminary draft will be due 3 months prior to the CDR, the final version will be due at CDR, and updates will be required as generated. All versions are for GSFC approval; however, the GSFC reviewers will only review the document to verify the "safety" of thermal, structural, electrical, etc. interfaces. | |
| Preparation Information:<br><br>This plan and its components will be prepared using MSFC standards/requirements/formats. Hence, MSFC may submit a compilation of documents, rather than one consolidated plan, to fulfill GSFC's safety review needs. Typically a verification plan describes the approach (test, analysis, etc.) that will be utilized to verify that the hardware/software complies with mission requirements. If verification relies on tests or analyses at other level of assemblies, describes the relationships. This plan typically includes:<br><br>• The GBM Verification Plan will include a section describing the environmental verification program. This includes level of assembly, configuration of item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, appropriate functional operations, personnel responsibilities, and requirements for procedures and reports. For each analysis activity, typically include objectives, a description of the mathematical model, assumptions on which the model will be based, required output, criteria for assessing the acceptability of the results, interaction with related test activity, and requirements for reports. Provide for an operational methodology for controlling, documenting, and approving activities not part of an approved procedure. Plan controls that prevent accidents that could damage or contaminate hardware or facilities, or cause personal injury generally include real-time decision-making mechanisms for continuation or suspension of testing after malfunction and a method for determining retest requirements, including the assessment of the validity of previous tests. Includes a test matrix that summarizes all tests to be performed on each component, each subsystem, and the payload. Includes tests on engineering models performed to satisfy qualification requirements. Defines pass/fail criteria.<br><br>• The Environmental Verification Plan summarizes all tests performed and shows the test and the level of assembly will be maintained.<br><br>• A System Performance Verification Matrix summarizing the flow-down of system specification requirements that stipulates how each requirement will be verified, and summarizes compliance/non-compliance with requirements. It shows each specification requirement, the reference source (to the specific paragraph or line item), the method of compliance, applicable procedure references, report reference numbers, etc. | |

- The Environmental Test Plan section typically includes an Environmental Test Matrix (ETM) that summarizes all environmental tests that will be performed showing the test and the level of assembly. Tests on development/engineering models performed to satisfy qualification requirements should included in this matrix.
- The Environmental Verification Specification that stipulates the specific environmental parameters used in each test or analysis required by the verification plan. Contains the specific test and analytical parameters associated with each of the tests and analyses required by the Verification Plan. Payload peculiarities and interactions with the spacecraft and launch vehicle shall be considered when defining quantitative environmental parameters under which the hardware elements must meet their performance requirements.

**GBM Verification Procedures**

| Title: GBM Verification Procedures | CDRL No.: 306 |
|---|---|
| Reference: MAR Sections 4.0 and 4.3 | |
| Use: Describes how each test activity defined in the Verification Plan will be implemented | |
| Related Documents: None | |
| Place/Time/Purpose of Delivery: Audit/review as required 30 days prior to the start of testing for safety implications and/or safety-related issues. | |
| Preparation Information:<br><br>The GBM Verification Procedures will be prepared using MSFC standards/requirements/formats. Describe the configuration of the tested item and the step-by-step functional and environmental test activity conducted at the unit/component, subsystem/instrument, and payload levels. Give details such as instrumentation monitoring, facility control sequences, test article functions, test parameters, quality control checkpoints, pass/fail criteria, data collection and reporting requirements. Address safety and contamination control provisions. Provide the methodology for controlling, documenting, and approving all activities not part of an approved procedure and establish controls for preventing accidents that could cause personal injury or damage to hardware and facilities. | |

**GBM Verification Reports**

| Title: GBM Verification Reports | CDRL No.: 307 |
|---|---|
| Reference: MAR Sections 4.0, and 4.4 | |
| Use: Summarize compliance with system specification requirements and/or provide a summary of testing and analysis results, including conformance, nonconformance, and trend data. | |
| Related Documents None | |
| Place/Time/Purpose of Delivery:<br><br>All GSFC reviews will be for safety implications or safety-related issues.<br><br>Verification Reports: Preliminary Report: 72 hours after test for GSFC information.<br>Final Report: 30 days after verification activity for GSFC information<br><br>System Performance Verification Report: Preliminary Report: At CDR.<br>Final Report: 30 days following on-orbit check out. | |
| Preparation Information:<br><br>These reports will be prepared using MSFC standards/requirements/formats.<br><br>Verification Report: Provide after each unit/component, subsystem/instrument, and payload verification activity. For each analysis activity the report shall describe the degree to which the objectives were accomplished, how well the mathematical model was validated by the test data, and other significant results.<br><br>System Performance Verification Report: Compare hardware/software specifications with the verified values (whether measured or computed). | |

**Program Parts List (PPL), And As Built Program Parts List (ABPL)**

| Title:<br>Program Parts List (PPL) and As-Built Parts List (ABPL) | CDRL No.:<br>308 |
|---|---|
| Reference:<br>MAR Sections 6.0 and 6.2 | |
| Use:<br>Listing of all EEE parts intended for use in flight hardware on the PPL and listing of all EEE parts installed in flight hardware on the ABPL. | |
| Related Documents<br>None | |
| Place/Time/Purpose of Delivery:<br>The initial PPL is due to GSFC 3 months after the PDR, the final is due 30 days prior to the CDR, and subsequent revisions (with all changes clearly noted on a hard copy) are due in a timely manner. The ABPL is due to GSFC 30 days prior to the GBM's shipment. All versions are due for GSFC information; however, GSFC has the right to disallow the usage of an EEE part for safety reasons. Note: The ABPL will be delivered in a database appropriate for GSFC EPIMS posting. | |
| Preparation Information:<br><br>The PPL/ABPL will be prepared and maintained throughout the life of the project in accordance with MSFC standards/requirements/formats. MSFC may reference the GSFC Mission Assurance Guidelines or the GSFC Parts Engineering Branch for information on suggested formats. | |

**Alert/Advisory Disposition**

| Title:<br>Alert/Advisory Disposition | CDRL No.:<br>309 |
|---|---|
| Reference:<br>MAR Sections 6.0 and 6.3 | |
| Use:<br>Review and the disposition of GIDEP Alerts and NASA Alerts and Advisories. | |
| Related Documents<br>None | |
| Place/Time/Purpose of Delivery:<br>Respond to GSFC within 1 month of the issue of an Alert/Advisory. Alert/Advisory impacts, if any, will be discussed at technical reviews. Disposition information will be provided for GSFC information; however, GSFC must approve "use as is" responses to Alerts/Advisories with safety implications. Alert/Advisory dispositions will be provided directly to both the GLAST Systems Assurance Manager and the GSFC GLAST Parts Engineer. | |
| Preparation Information:<br><br>MSFC will provide an impact statement to GSFC for each GIDEP/NASA Alert or Advisory reviewed. When a negative impact exists, MSFC will provide, within 1 month, a narrative plan of action and an implementation date so GSFC can perform a safety review. Alert/Advisory dispositions will be provided directly to both the GLAST Systems Assurance Manager and the GSFC GLAST Parts Engineer. | |

**Materials, Lubrication, And Processes Lists Plus Related Documentation**

| Title:<br>Materials, Lubrication, and Processes Lists Plus Related Documentation | CDRL No.:<br>310 |
|---|---|
| Reference:<br>MAR Sections 7.0 and 7.2 | |
| Use:<br>For usage evaluation of all polymeric and composite materials applications; all metal, ceramic, and metal/ceramic composite material applications; all lubricant usage and applications; and all material processes that are used to fabricate, clean, store, integrate, and test the space flight hardware. | |
| Related Documents:<br>NASA RP-1124, ASTM E 595, MSFC-HDBK-527, NHB 1700.7, EWR 127.1, GMI 1700.3, and NASA-STD-6001, MSFC-STD-3029 | |
| Place/Time/Purpose of Delivery:<br>Provide the list to GSFC 3 months before CDR for safety review/information. Additionally, the current list will be provided to GSFC 6 months after the CDR and 30 days before hardware delivery to the spacecraft contractor for safety review/information. Any updates will be delivered to GSFC for review as generated. Additional information on material waivers, fasteners, processes, and raw material information will be delivered upon request by GSFC for information for a safety review. | |
| Preparation Information:<br><br>The Materials, Lubrication, and Processes Lists will cover information on polymeric materials and composites usage, inorganic materials and composites usage, lubrication usage, and material process utilization. MSFC will utilize their internal standards/requirements/formats to prepare these lists which will only be reviewed by GSFC for safety/"do no harm" implications. MSFC may reference the GSFC Mission Assurance Guidelines or the GSFC Materials Engineering Branch for information on suggested formats. Supporting material may be requested by GSFC to facilitate the safety review of material, lubrication, or process application/use.<br><br>Additional deliverable information includes:<br><br>• The usage of materials with expired date codes or other safety concerns/implications may be accomplished by means of a waiver approved by GSFC.<br><br>• Fastener information will be provided to GSFC upon request for a safety review.<br><br>• A copy of any process that requires a safety review will be submitted to GSFC upon request.<br><br>• Raw materials should be accompanied by the results of nondestructive, chemical and physical tests, or a Certificate of Compliance. Raw material certificates of compliance, test results and analyses, etc. will be submitted to GSFC upon request. | |

**Failure Mode and Effects Analysis (FMEA) and Critical Items List (CIL)**

| Title: Failure Mode and Effects Analysis (FMEA) and Critical Items List (CIL) | CDRL No.: 311 |
|---|---|
| Reference: MAR Sections 8.0 and 8.2.1 | |
| Use: To evaluate the design relative to requirements, identify single point failures, and identify hazards. GSFC's review will concentrate on safety/"do no harm" aspects of the design, especially the interfaces. | |
| Related Documents S-302-89-01, "Procedures for Performing an FMEA;" CR 5320.9, "Payload and Experiment Failure Mode Effects Analysis and Critical Items List Ground Rules;" and MIL-STD 1629A, "Procedures for Performing an FMECA" | |
| Place/Time/Purpose of Delivery: A preliminary draft is due to GSFC 3 months prior to the CDR for safety review/information, focusing on spacecraft/GBM and any GBM/LAT interface. Additionally, the final version will be provided to GSFC 3 months after the to the CDR for a similar review. Updates will be delivered to GSFC as generated for similar safety reviews. Changes from previous versions should be clearly noted on the updates and final versions. | |
| Preparation Information:<br><br>The FMEA and CIL will be prepared and maintained in accordance with MSFC standards/ requirements/formats. | |

**Worst Case Analysis (WCA)**

| Title:<br>Worst Case Analysis (WCA) | DID No.:<br>312 |
|---|---|
| Reference:<br>MAR Sections 8.0 and 8.2.2 | |
| Use:<br>To demonstrate adequacy of margins in the design of electronic circuits, optics, electromechanical, and mechanical items. GSFC's review will concentrate on safety/"do no harm" aspects of the design, especially the interfaces. | |
| Related Documents:<br>None | |
| Place/Time/Purpose of Delivery:<br>A preliminary draft is due to GSFC 3 months prior to the CDR for safety review/information, focusing on spacecraft/GBM and any GBM/LAT interface. Additionally, the final version will be provided to GSFC 3 months after the CDR for a similar review. Updates will be delivered to GSFC as generated for similar safety reviews. Changes from previous versions should be clearly noted on the updates and final versions. | |
| Preparation Information:<br><br>The WCA will be prepared and maintained in accordance with MSFC standards/ requirements/formats. | |

**Contamination Control Plan**

| Title:<br>Contamination Control Plan | CDRL No.:<br>313 |
|---|---|
| Reference:<br>MAR Sections 10.0 and 10.1 | |
| Use:<br>To establish contamination allowances and methods for controlling contamination | |
| Related Documents:<br>None | |
| Place/Time/Purpose of Delivery:<br>A preliminary draft is due to GSFC 3 months before the CDR for GSFC review. The final draft is due to GSFC 1 month after the CDR and subsequent updates are due as generated for approval. | |

Preparation Information:

The CCP will:

a. Describe specific cleanliness requirements and approaches
b. Describe the procedures that will be followed to control contamination
c. Define a contamination allowance for performance degradation of contamination sensitive hardware such that, even in the degraded state, the hardware shall meet its mission objectives
d. Establish the implementation and describe the methods that will be used to measure and maintain the levels of cleanliness required during each of the various phases of the hardware's lifetime
e. Ensure that the GBM is compatible with the most contamination-sensitive mission components
f. Provide data on material properties, design features, test data, system tolerance of degraded performance, and methods to prevent degradation for independent evaluation of contamination hazards.

Additionally, the CCP will cover:

1. Materials – Including outgassing as a function of temperature and time; the nature of outgassing chemistry; and areas, weight, location, and view factors of critical surfaces
2. Venting – Including size, location, and relation to external surfaces
3. The thermal vacuum test contamination monitoring plan – Including vacuum test data, QCM rates and location, temperature and pressure data, system temperature profile, and shroud temperature
4. On orbit spacecraft and instrument performance as affected by contamination deposits – Including contamination effect monitoring; methods to prevent and recover from contamination in orbit; how to evaluate in orbit degradation; photopolymerization of outgassing products on critical surfaces; space debris risks and protection; and atomic oxygen erosion and re-deposition
5. MOLEFLUX or equivalent analysis of contamination impact on the satellite's on-orbit performance
6. In orbit contamination impact from other sources such as adjacent instruments